इंटरनेट मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

“जानने का अधिकार, जीने का अधिकार”
Mazdoor Kisan Shakti Sangathan
“The Right to Information, The Right to Live”

“पुराने को छोड नये के तरफ”
Jawaharlal Nehru
“Step Out From the Old to the New”

IS 3203 (1982): Methods of testing local thickness of electroplated coatings_ [MTD 7: Light Metals and their Alloys]

Act Number 22 of 2005
The Indian Parliament
RIGHT TO INFORMATION

“ज्ञान से एक नये भारत का निर्माण”
Satyanarayan Gangaram Pitroda
“Invent a New India Using Knowledge”

Made Available By
Public.Resource.Org

“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”
Bhartṛhari—Nītiśatakam
“Knowledge is such a treasure which cannot be stolen”

BLANK PAGE

BRUTUM FULMEN

IGNORANTIA JURIS NON EXCUSAT

PROTECTED BY COPYRIGHT

IS 3203 : 1982
(Reaffirmed 1998)

REAFFIRMED
MAR 2006

Indian Standard

METHODS FOR TESTING LOCAL THICKNESS OF ELECTROPLATED COATINGS

(First Revision)

Fifth Reprint OCTOBER 2000

UDC 621.357-7 : 531.717.11

© *Copyright* 1983

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 5

February 1983

AMENDMENT NO. 1 FEBRUARY 1987

TO

IS : 3203-1982 METHODS FOR TESTING LOCAL THICKNESS OF ELECTROPLATED COATINGS

(First Revision)

(*Page* 7, *clause* **5.1**) — Add the following new clause after **5.1**:

'**5.1.1** *Accuracy* — Under optimum conditions, the errors involved in this method are normally within ±15 percent.'

(*Page* 8, *clause* **5.3.1.1**, *line* 2) — Substitute the following for the existing matter:

'Anhydrous ferric chloride ($FeCl_3$) 180 g'

(*Page* 9, *clause* **5.3.2.1**) — Add the following new clause after **5.3.2.1** :

'**5.3.2.2** To distinguish between bright and dull electroplated nickel coatings, a simple method of testing as given in Appendix B may be adopted.'

(*Page* 10, *clause* **5.3.6**) — Substitute '260 g' *for* '250 g' against Potassium iodide.

(*Page* 10, *clause* **5.3.7**, *line* 1) — Substitute '100 g' *for* ' 120 g'.

(*Page* 18, *clause* **6.3**) — Add the following Note under **6.3**:

'NOTE — The test specimen and test solution should normally be kept between 16 and 25°C. The temperature up to 30°C is permissible since the measurement becomes less reliable at the higher temperature.'

(*Page* 18, *clause* **6.5**) — Substitute the following for the existing clause:

'**6.5** Record the time to the nearest half second with a stop-watch from the appearance of black film over the surface under test to the cessation of gassing. Note down room temperature near the test area to accuracy of 0·2°C.'

(*Page* 18, *clause* **6.6**) — Add the following new clause after **6.6**:

'**6.7 Accuracy** — The thickness determination by this method has an uncertainty about ±20 percent, and is, therefore, much less accurate than coulometric method specified in the product specifications.'

(*Page* 19, *clauses* **A-3** *and* **A-3.1**, *line* 1) — Substitute ' coulometric ' *for* ' colometric '.

(*Page* 19, *clause* **A-3.2**) — Add the following Appendix B after this clause:

'APPENDIX B

(*Clause* 5.3.2.2)

METHOD OF TESTING TO DISTINGUISH BETWEEN BRIGHT AND DULL ELECTROPLATED NICKEL COATINGS

B-1. GENERAL

B-1.1 In testing the thickness of nickel (single) coatings the usual end points have been given. But the coating sometimes shows a darkening of the test-spot by a non-adherent blackish matter which may need to be wiped off at intervals with a stub of paper. While the dull and cobalt-nickel bright-nickel coatings give a normal rate of attack and no correction is needed, the rate of penetration of 'organic bright-nickel' coatings may be different and a correction factor may be required. These organic bright-nickel coatings may be detected as given below.

B-2. PREPARATION OF SURFACE

B-2.1 Roughen the surface slightly by rubbing with fine pumice powder (no other abrasive power should be used). Dry the surface with a clean cloth.

B-3. PREPARATION OF THE TEST SOLUTION

B-3.1 The test solution shall be prepared by dissolving 20 g of chromic acid and 10 ml of concentrated sulphuric acid in 100 ml of distilled water.

B-4. PROCEDURE

B-4.1 Apply a drop of cold test solution on the clean surface. If attack occurs rendering the drop brown within 5 minutes, the deposit is organic bright-nickel.

NOTE — It is reported that organic bright-nickel deposits from solutions containing sulphonic acids and other organic additives dissolve more rapidly than dull-nickel and that the true thickness may be obtained by multiplying the jet-test thickness by a factor of 1·5. However, this factor should be obtained from the manufacturer of the proprietory brighteners, as this factor may vary from one manufacturer to another.

B-4.2 Correction Factor —Correction curves based to proprietory nickel brighteners and an average curve is given in Fig. 9. The true thickness of bright nickel depends on the nickel thickness as calculated from Fig. 2 of this standard. In case of doubt it is advisable to compare jet-test results on 3 or 4 samples of different nickel thicknesses with thickness measurement by some other standard methods to see if the curve is needed or a simple correction will suffice.'

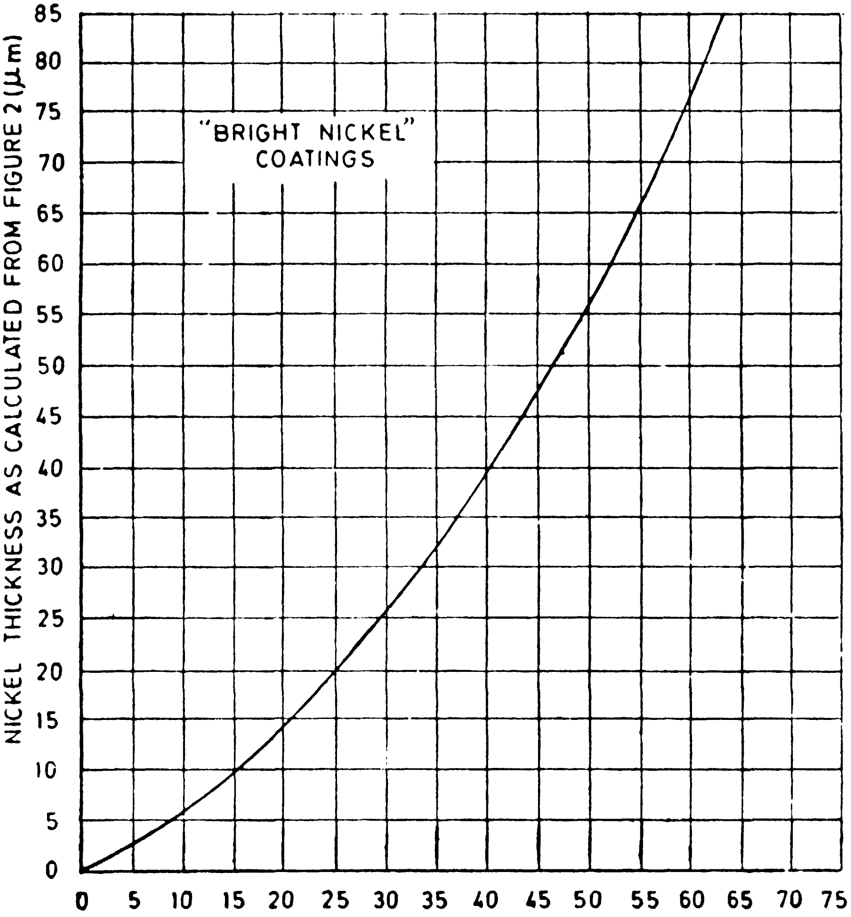


FIG. 9 CORRECTION CURVES BASED TO PROPRIETORY NICKEL BRIGHTENERS AND AN AVERAGE CURVE

(SMDC 23)

Printed at New India Printing Press, Khurja, India

IS 3203 : 1982
(**Reaffirmed 1987**)

Indian Standard

METHODS FOR TESTING LOCAL THICKNESS OF ELECTROPLATED COATINGS

(First Revision)

Metallic Finishes Sectional Committee, SMDC 23

Chairman	*Representing*
Dr R. C. Sharma	Eveready Flashlight Company, Lucknow
Members	
Shri K. Balakrishnan	Central Electrochemical Research Institute (CSIR), Karaikudi
Shri S. R. Natarajan (*Alternate*)	
Shri G. S. Bhattacharjee	Ministry of Defence (R&D)
Shri I. N. Bhatia (*Alternate*)	
Shri S. C. Bhawal	National Test House, Calcutta
Shri A. K. Kalra (*Alternate*)	
Shri A. T. Borate	Premier Automobiles Ltd, Bombay
Shri A. G. Prabhu (*Alternate*)	
Shri M. S. Chakravorty	Premier Metal Finishers (P) Ltd, Calcutta
Shri R. K. Chatterjee (*Alternate*)	
Shri Kantilal T. Dalal	Kohinoor Electro-Gilders, Bombay
Shri Jayendra K. Dalal (*Alternate*)	
Dr R. P. Dambal	Indian Telephone Industries Ltd, Bangalore
Deputy Director (Met-4), RDSO, Lucknow	Ministry of Railways
Chemist & Metallurgist, ICF, Madras (*Alternate*)	
Shri G. T. Deshmukh	Perfect Industries, Pune
Shri G. S. Ekbote (*Alternate*)	
Shri S. E. Emanual	Hindustan Aeronautics Ltd, Bangalore
Shri S. N. Gana	Indian Posts and Telegraphs Department, Calcutta
Shri P. B. Syam (*Alternate*)	
Shri S. S. Guha	Ministry of Defence (DGI)
Shri P. K. Sen (*Alternate*)	
Shri K. Hiralal	NGEF Ltd, Bangalore
Shri Aswathanarayana (*Alternate*)	
Shri V. S. Kulkarni	Grauer and Weil (India) Ltd, Bombay
Shri Sushil Goinka (*Alternate*)	

(*Continued on page* 2)

© *Copyright* 1983
BUREAU OF INDIAN STANDARDS
This publication is protected under the *Indian Copyright Act* (XIV of 1957) and reproduction in whole or in part by any means except with written permission of the publisher shall be deemed to be an infringement of copyright under the said Act.

(*Continued from page* 1)

Members	*Representing*
SHRI M. A. KATIBHASKAR	Canning Mitra Phoenix Ltd, Bombay
DR R. G. JADHAV (*Alternate*)	
DR S. KRISHNAMURTHY	In personal capacity (*Shubhodaya, 38 XI Main Road, Malleswaram, Bangalore*)
DR S. K. NARANG	National Metallurgical Laboratory (CSIR), Jamshedpur
SHRI G. RAMAMURTHY	Tata Engineering and Locomotive Company Ltd. Jamshedpur
SHRI R. SEN	Hindustan Cables Ltd, Rupnarainpur (Dist Burdwan)
SHRI KALYAN GHOSH (*Alternate*)	
SHRI R. A. SHAH	Ronuk Industries Ltd, Bombay
KUMARI MRIDULA A. SHAH (*Alternate*)	
SHRI R. SOMASEKHARA	Bharat Electronics Ltd, Bangalore
SHRI K. NAGESH (*Alternate*)	
SHRI V. THIYAGARAJAN	Development Commissioner (Small Industries Services Institute), New Delhi
SHRI R. VENKATARAMAN	T.I. Cycles of India, Madras
SHRI C. R. RAMA RAO, Director (Struc & Met)	Director General, ISI (*Ex-officio Member*)

Secretary

SHRI S. K. GUPTA
Assistant Director (Met), ISI

Indian Standard

METHODS FOR TESTING LOCAL THICKNESS OF ELECTROPLATED COATINGS

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 22 October 1982, after the draft finalized by the Metallic Finishes Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 One of the important requirements specified in Indian Standards on electroplating is the thickness of a coating. This standard has been prepared with a view to prescribing suitable methods for determination of local thickness of the electro-deposit. Microscopic method has been recommended in this standard as a referee method, which shall be used in case of dispute. Besides, magnetic method and BNF jet test have been included for routine and control purposes. Several instruments based on the principle of eddy current, thermoelectricity and coulometry are in common use. Any of these instruments may be employed by agreement between the supplier and the purchaser.

0.3 This standard was earlier published in 1965. In this revision, a correction factor for the determination of coating thickness for bright nickel coating has been recommended in **5.3.2**. The graph given at Fig. 6 has also been extrapolated up to 40°C to aid correct examination of silver coating at higher temperatures. The eddy current method given in Appendix A has been deleted and instead reference is made to IS : 6012-1971*.

0.4 In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960†.

---

*Method for measurement of coating thickness by eddy current.

†Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 The methods prescribed in this standard covers procedures for measuring local thickness of electroplated coatings of copper, brass, nickel nickel-chromium, hard chromium, lead, zinc, cadmium, silver, gold and tin.

2. QUALITY OF REAGENTS

2.1 Unless otherwise specified, AR quality chemicals shall be employed in the test and distilled water (*see* IS : 1070-1977*) shall be used when the use of water as a reagent is intended.

3. DETERMINATION OF THICKNESS BY MICROSCOPIC (REFEREE METHOD)

3.1 **Preparation of Section for Test** — Cut a section of the specimen at one or more points of the significant surface where a minimum thickness may be expected.

NOTE — It is advisable to determine thickness on large or irregularly shaped parts at several points.

3.2 **Mounting of Specimens** — Hold one or more test specimens in a clamp. On soft coatings, such as lead, use the minimum pressure which will ensure continuous contact without causing extrusion of the coating. Mount the specimens in a plastic material, such as a phenolic or acrylate resin, or if the melting point of the coating permits, mount them in a low melting alloy. In mounting care should be taken that voids do not form between the specimen and the mounting material. Hold the specimen rigidly and in such a position that the surface to be tested is perpendicular to the flat face that is to be ground and polished. (A deviation of 10 deg from normal introduces an error of about 2 percent in thickness). The pieces may be plated first with a relatively thick coating of copper to protect the edges during grinding and polishing. On zinc or cadmium, deposit the first layer of copper from a cyanide solution, after which, if desired, an acid copper solution may be used.

3.3 **Preparation of Section** — Grind and polish the section to be examined, using successively finer abrasives, the last being no coarser than 500 mesh. In polishing chromium coatings continue the first polishing operation until all chromium which cracked or flaked during the initial cutting operation has been removed and a true section appears under the microscope. Polish zinc, cadmium, and lead coatings with minimum pressure, in the direction from the hard basis metal to the soft coating, and alternately at 45 deg and 135 deg to the plated surface. In polishing lead coatings, run the last polishing wheels at low speed not exceeding 250 rpm.

---

*Specification for water for general laboratory use (*second revision*).

3.3.1 Then treat the surface in such a manner as to obtain the maximum contrast between the coating and the adjacent metal. Obtain uch contrast by etching either the coating or the adjacent metal by an ppropriate reagent (*see* Note). Suitable etching is desirable even when he contrast exists, since it will remove any soft metal that may have pread over a harder metal.

NOTE — The following typical reagents are suitable for etohing plated coatings:

a) *For nickel or chromium on steel*

Reagents to etch steel:

Concentrated nitric acid, r.d. 1·42 (conforming to IS : 264-1976*)	5 volumes
Alcohol (95 percent)	95 volumes

b) *For nickel over copper and copper alloys including copper undercoatings on steel, zinc and zinc base alloys*

Reagents to etch copper:

Ammonium hydroxide (20 percent)	1 volume
Hydrogen peroxide (3 percent)	1 volume

c) *For zinc or cadmium coatings on steel and for nickel coatings directly on zinc and zinc base alloys*

Reagents to etch zinc or cadmium:

Chromic acid (CrO_3)	200 g/l
Sodium sulphate (Na_2SO_4)	15 g/l

d) *For lead on steel, including copper flashed steel*

Reagents to etch steel:

Ferric chloride ($FeCl_3 6H_2O$)	10 g
Concentrated hydrochloric acid, r.d. 1·16 (conforming to IS : 265-1976†)	2 ml
Water	95 ml

e) *For gold and silver on copper*

Sodium or potasium cyanide solution (10 percent)	1 volume
Ammonium persulphate solution (10 percent)	1 volume

f) *For tin and tin alloy coatings on copper and copper alloys*

Ammonium persulphate	10 g
Ammonia solution (r.d. 0·9)	2 ml
Distilled water (to be freshly prepared)	90 ml

---

*Specification for nitric acid (*second revision*).

†Specification for hydrochloric acid (*second revision*).

3.4 Procedure — Measure the thickness of the coating at any desired point on the exposed section by either of the methods described in **3.4.1** and **3.4.2**.

3.4.1 Measure the thickness with a filar micrometer ocular that has been calibrated in order to determine the value of the unit scale division against a scale graduated so accurately that the error will not exceed 2 percent. For example, the scale may be graduated to 0·01 mm.

3.4.2 Project the image of the specimen, especially of those specimens having very thin coatings, at a known and properly calibrated magnification of the ground-glass focusing plane of the camera of metallographic microscope. Measure the width of the projected line of deposit with a graduated linear scale; the reading divided by the magnification gives the thickness of the coating.

4. DETERMINATION OF THICKNESS BY MAGNETIC METHOD

4.1 Principle of the Test — Magnetic method involves instruments which measure either the attractive force between a magnet and the coated specimen or the reluctance of a flux path through the coating and the basis metal. Either the attractive force or the reluctance as measured is a function of the thickness of the coatings. These methods may be used to measure the thickness of non-magnetic or nickel coatings on a magnetic basis metal, such as steel, or thickness of magnetic coatings on a non-magnetic basis metal, and the thickness of nickel and copper in a composite nickel-over-copper coatings on steel.

4.2 Apparatus — Any commercially available instrument may be used for measurement. The following three systems are in use employing the following types of apparatus:

a) *Permanent Magnet* — A permanent magnet suspended from a spring balance by which the attractive force is measured. At present this type is the only one suitable for measuring nickel coatings and composite nickel-over-copper coatings on steel;

b) *Moveable Iron Core* — A moveable iron core within a glass tube and a solenoid around the tube which is gradually moved away from the core disengages from the surface being tested; and

c) *A Pair of Magnetic Poles* — A pair of magnetic pole pieces with means for measurement of the reluctance of the flux path.

4.3 Calibration — Each instrument, including the magnet to be used, shall be calibrated against coating of known thickness before use and the calibration should be checked at frequent intervals.

4.4 Measurement — After standardization of the apparatus, the probe of the magnet shall be placed over the electroplated coating and the thickness of the coating directly recorded from the instrument.

4.5 Accuracy — This method is suitable for measurement of thickness on plain surfaces. Curved surfaces may also be measured provided the radius of curvature is at least three times the diameter of the magnet. Where the basis metal is very thin (less than 0·25 mm), it is essential to back it up by an extra piece of similar basis metal so that the necessary attractive force is developed. Under optimum conditions, the errors involved in this method are normally within ± 10 percent.

4.6 Factors Affecting Applicability and Accuracy of Measurement — The following conditions may affect the result obtained by a given instrument:

a) Smoothness of the surface, including that of the basis metal;

b) Thickness of the magnetic basis metal;

c) Magnetic properties of the basis metal, including permeability, retentivity, and residual magnetism;

d) Magnetic properties of the coating (*see* Note 1);

e) Stickiness of the coating (*see* Note 2);

f) Curvature of the article at the point being tested in relation to the size, shape and strength of the magnetic pole;

g) Distance between the point being tested and an edge of the article;

h) Thickness of any magnetic coating on the side of a thin basis metal opposite to that being tested;

j) Deviation of the magnet axis from a line perpendicular to the surface at the point of measurement; and

k) Grain orientation in the steel basis metal.

NOTE 1 — Nickel coatings, especially bright nickel coatings vary greatly in magnetic properties, requiring frequent standardization or suitable annealing.

NOTE 2 — Lead coatings stick easily to the magnet pole and require treatment with a very light film of mineral oil to ensure reproducibility of readings.

5. DETERMINATION OF THICKNESS BY BNF JET TEST METHOD

5.1 Principle of the Test — A jet of a constantly replacing corroding solution is allowed to impinge on a small area of the test surface to be tested, and the time required to penetrate the plating layer is measured. This time is a function of thickness of plating layer and the temperature. The thickness may then be obtained from a suitably calibrated curve in which the time is plotted against the temperature for given thickness.

5.2 Apparatus — The apparatus (*see* Fig. 1) shall have the following features:

a) *Constant Head Device* (*A*) — Glass tube to maintain constant head of the solution.

b) *Separatory Funnel* (*B*)

c) *On-Off Stopcock* (*C*)

d) *Nozzle* (*D*) — enclosed in glass guard tube and connected to the funnel by rubber tubing. A nozzle consisting essentially of a glass capillary tube of 1·5 mm bore and not less than 100 mm in length, drawn out into a smooth taper at the nozzle end shall be used to deliver the solution in a jet form. The dimensions of the tapered portion should be such that:

$$\frac{D - d}{L} \text{ shall be between } 0{\cdot}030 \text{ and } 0{\cdot}045 \text{ mm.}$$

where

D = internal diameter of the capillary tube,

d = internal diameter of the tip of the nozzle, and

L = length of the taper.

The jet should deliver 10 ml of water at 27 ± 2°C in 27 to 29 seconds under a constant head of 250 mm.

e) *Sliding Clamp* (*E*)

f) *Clamp for Test Specimen* (*F*)

g) *Dish to Receive Used Solution* (*G*)

h) *Base with Levelling Screws* (*H*)

5.3 Reagents

5.3.1 *Reagent for Copper and Nickel Coating*

5.3.1.1 The reagent shall be of the following composition:

Anhydrous ferric chloride ($FeCl_3, 6H_2O$)	300 g
Copper sulphate	100 g
Water	To make up to one litre

5.3.1.2 *Concentrated hydrochloric acid* — r.d. 1·16 (conforming to IS : 265-1976*).

---

*Specification for hydrochloric acid (*second revision*).

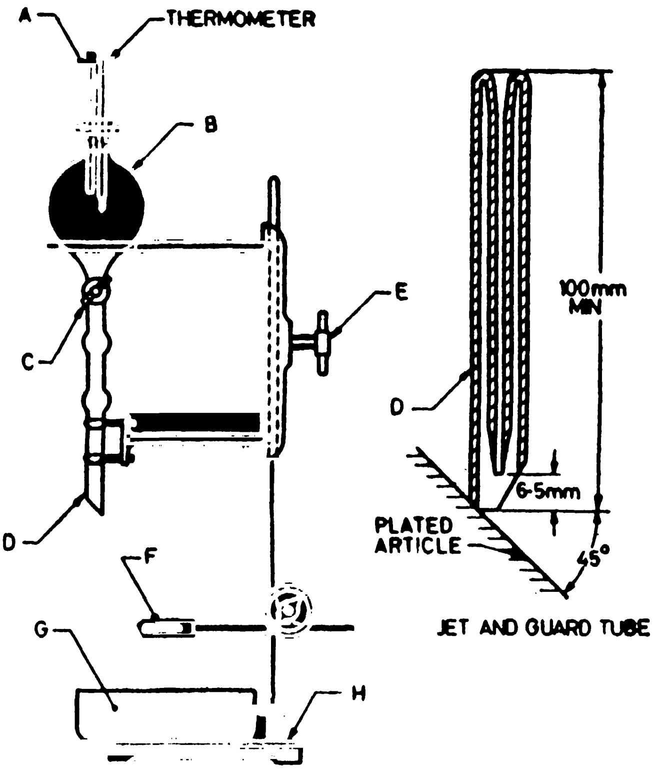


FIG. 1 APPARATUS FOR BNF JET TEST

5.3.2 *For Bright Nickel Coating*

5.3.2.1 For the determination of coating thickness of bright nickel deposits, a correction factor shall be required. This factor may be obtained from the supplier of the brightner or computed by the user himself.

5.3.3 *Reagent for Lead Coating*

5.3.3.1 The reagent shall be of the following composition:

Acetic acid (glacial)	1 volume
Hydrogen peroxide (20 v)	1 volume
Water	To make up to 3 volumes

NOTE — The solution should be freshly prepared and standardized before use so that 2·5 ml of the reagent consumes 14·95 ml of potassium permanganate (0·1 N).

5.3.3.2 *Concentrated hydrochloric acid* — *See* **5.3.1.2**.

5.3.4 *Reagent for Zinc Coating* — The reagent shall be of the following composition:

Ammonium nitrate	70 g
One normal hydrochloric acid	70 ml
Water	To make up to one litre

5.3.5 *Reagent for Cadmium Coating* — The reagent shall be of the following composition:

Ammonium nitrate	17·5 g
One normal hydrochloric acid	17·5 ml
Water	To make up to one litre

5.3.6 *Reagent for Silver Coating* — The reagent used in the test shall have the following composition.

Potassium iodide	250 g
Resublimed iodine	7·5 g
Water	To make up to one litre

NOTE — Standardize the solution by titrating with standard sodium thiosulphate solution (0·1 N) to contain exactly 7·44 g of iodine per litre.

5.3.7 *Reagent for Tin Coating* — Take 120 g of trichloracetic acid and dilute it to one litre with water. Adjust its strength in such a way that 25 ml require 30·6 ml of sodium hydroxide solution (0·5 N) when titrated using thymol blue as indicator.

5.4 Preparation of the Apparatus

5.4.1 Adjust the levelling screws of the apparatus to prevent rocking. Fill about three-quarters of the funnel with the reagent solution. Open the tap of the funnel so that the tube and jet are completely filled with the solution. It is necessary to hold the finger over the jet and pinch the rubber connecting tube several times to displace the air bubles.

5.4.2 Insert tightly the rubber stopper containing the constant head device and thermometer so that the bottom end of the former (that is, where the bubbles emerge) is 250 mm above the jet, and draw off the solution until air bubbles pass through regularly. Remove any superfluous solution from the guard tube by means of filter paper.

5.5 Preparation of Surface of Testing

5.5.1 Degrease the test piece by rubbing with a damp cloth, on which light magnesium oxide has been sprinkled. Rinse with acetone and dry in air. Abrasives shall not be used.

5.5.2 In case of testing nickel deposit, dip the article in a mixture of equal volumes of concentrated hydrochloric acid (*see* **5.3.1.2**) and water, to remove the slightly protective film on the surface of nickel.

5.5.3 In case of passivated zinc coating, immerse the article for a few seconds in 5 percent acetic acid solution, rinse with water, scour with a little magnesium oxide on wet cotton wool, finally rinse with water and dry with a grease-free cloth or absorbent paper.

5.5.4 In case of tin plating, degrease the sample with trichlorethylene, and then treat cathodically at 6 volts for 15 seconds in a cold 5 percent solution of sodium carbonate.

5.5.5 In case of lead plating, samples to be tested should preferably be freshly plated or kept in desiccator.

5.6 Procedure

5.6.1 Clamp the degreased specimen so that the surface under test is at an angle of about 45° to the horizontal and about 6·5 mm below the tip of the jet. This means that most of the specimen will just touch the lower part of the guard tube enclosing the nozzle. The specimen is so clamped that there is no relative movement between the nozzle and specimen, and there is a free fall of the solution into the dish below.

5.6.2 Open the stopcock and also start a stop-watch simultaneously. After 5 to 10 seconds, stop both and examine the sample for penetration. Repeat the process without moving the specimen until the first sign of penetration is seen immediately below the nozzle.

5.6.3 *Calculation* — Find out from the graph the time required to penetrate 0·002 5 mm of deposit at the particular temperature of testing. The thickness (T) in mm of the coating may then be calculated from the following formula:

$$T = \frac{A}{B} \times 0{\cdot}002\,5$$

where

A = time in seconds to penetrate deposit under test, and

B = time in seconds to penetrate 0·002 5 mm (as obtained from the relevant figures, *see* Fig. 2 to 7).

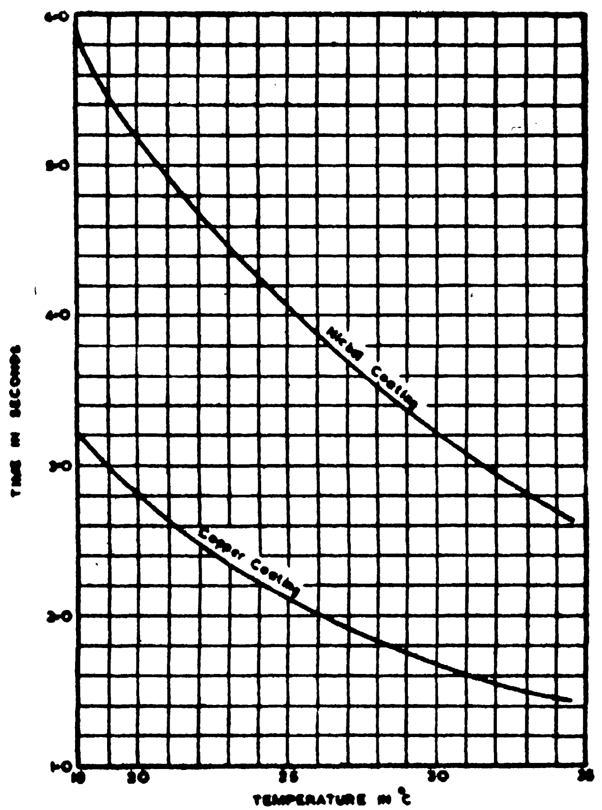


FIG. 2 TIME REQUIRED TO PENETRATE 0·002 5 mm OF COPPER AND NICKEL AT DIFFERENT TEMPERATURES

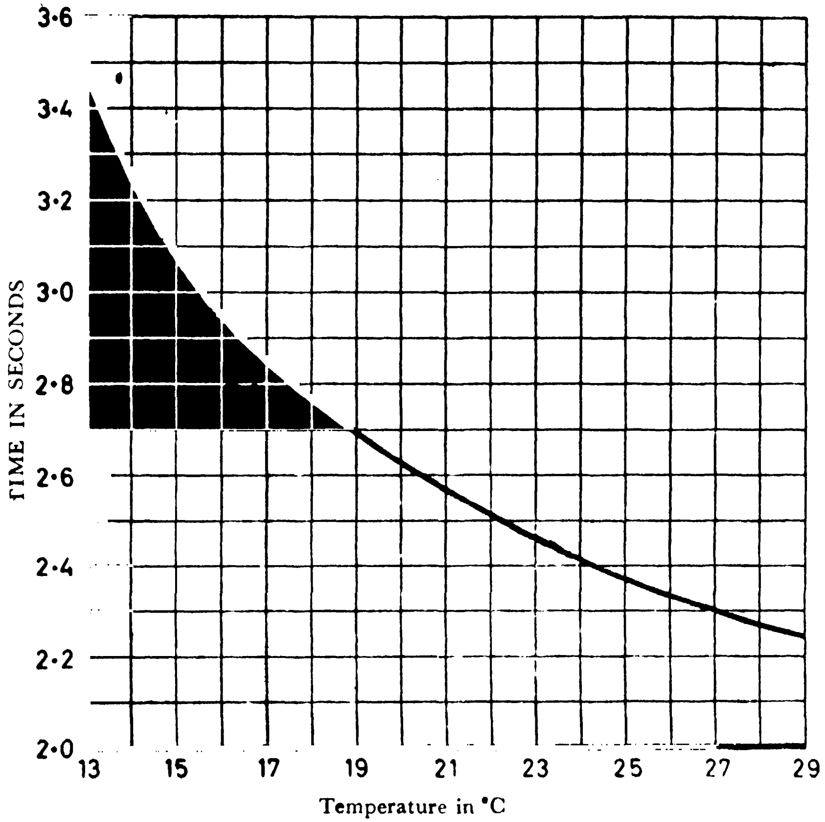


FIG. 3 TIME REQUIRED TO PENETRATE 0·002 5 mm OF LEAD AT DIFFERENT TEMPERATURES

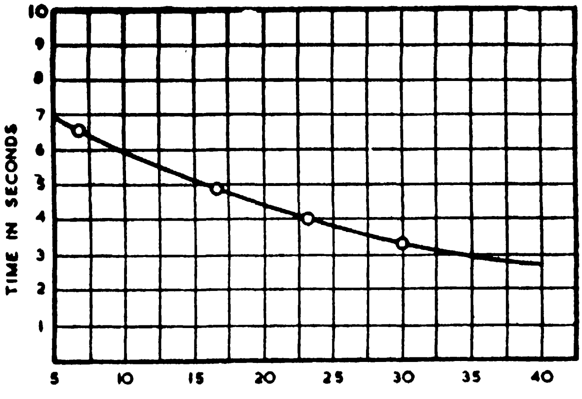


FIG. 4 TIME REQUIRED TO PENETRATE 0·002 5 mm OF ZINC AT DIFFERENT TEMPERATURES

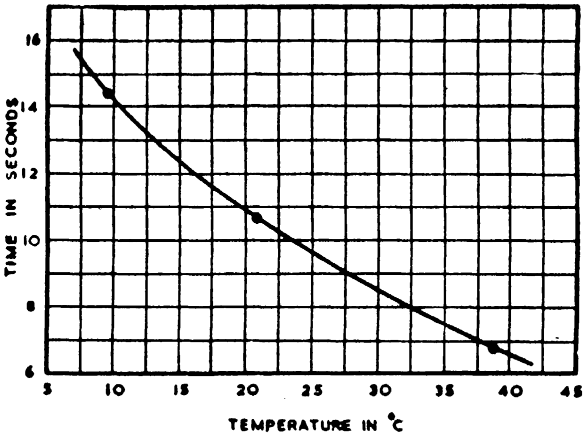


FIG. 5 TIME REQUIRED TO PENETRATE 0·002 5 mm OF CADMIUM AT DIFFERENT TEMPERATURES

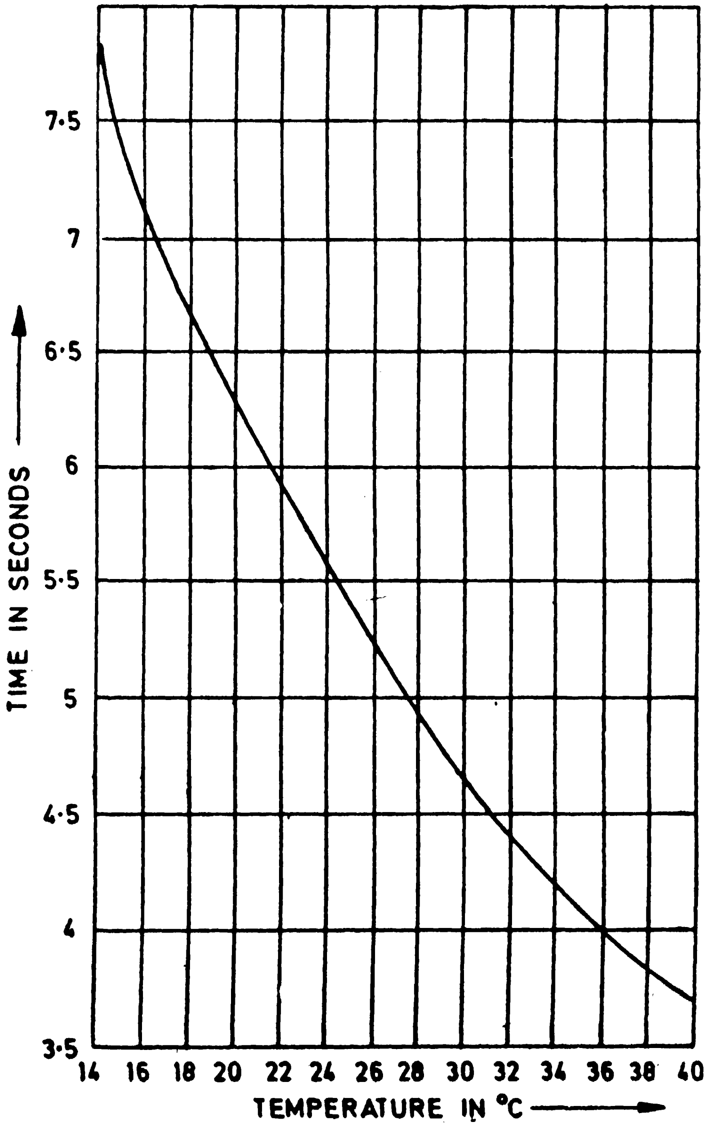
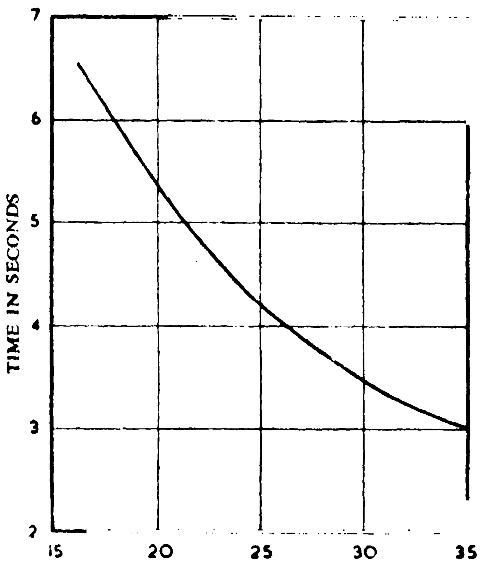


Fig. 6 Time Required to Penetrate 0·002 5 mm of Silver at Different Temperatures



Temperature in °C

FIG. 7 TIME REQUIRED TO PENETRATE 0·002 5 mm OF TIN AT DIFFERENT TEMPERATURES

5.6.3.1 The end point is indicated by the contrast in appearance between the exposed spot of basis metal and the coating. The appearance of the spot after test is useful criterion of its accuracy. It should be very small single spot and preferably crescent-shaped. Tests giving double spot or diffused area of perforation should be rejected.

5.6.4 *Indication in Case of Penetration of Copper and Nickel*

5.6.4.1 Penetration of the copper coatings shall be indicated by the following signs:

Basis Metal	*Mark*
a) Aluminium and zinc base alloys	Black spot
b) Nickel	White spot
c) Steel	Copper spot (*see* Note)

NOTE — The copper spot is not readily detectable as it is of the same colour as the surrounding surface. To help distinguish, put 2 drops of either of the following solutions:

1) One gram of antimony trioxide added to 100 ml of concentrated hydrochloric acid (*see* **5.3.1.2**), and

2) *Chromium stripping solution* — Dissolve 20 g of antimony trioxide (Sb_2O_3) in one litre of concentrated hydrochloric acid (*see* **5.3.1.2**).

5.6.4.2 Penetration of nickel coatings shall be indicated by the following signs:

Basis Metal	*Mark*
a) Steel	Copper spot (*see* Note)
b) Copper	Copper spot which shows up at once
c) Brass	Brownish yellow spot
d) Aluminium	Central black spot with a halo of copper
e) Zinc base alloys	Black spot similar to that of aluminium

NOTE — This copper spot is not formed until the flow is stopped for a few seconds. Owing to the solubility of metallic copper in the excess of the solution, a luminary copper coloured blush may form due to pores, but a definite central perforation point should be obtained.

5.6.5 *Indication of End Point in Case of Cadmium Plating* — The end point is indicated by the contrast in appearance between the exposed spot of basis metal and the coating. With plain cadmium coatings on steel, it has occasionally been found difficult to direct appearance of the steel when the coating is perforated. It has been helpful in such cases to apply one or two drops of special indicator solution to the test spot.

5.6.5.1 The following is the composition of special indicator solution:

Mercuric chloride	10 g
Concentrated hydrochloric acid (*see* **5.3.1.2**)	50 ml
Water	To make up to 100 ml

5.6.5.2 The effect of indicator solution at perforation will be bright mercury spot on exposed steel and black on cadmium.

5.6.6 It is important that any further thickness testing should be carried out on a portion of the surface not wetted by the indicator solution as a film is produced on cadmium which protects it from the jet reagents.

5.6.7 Deposits produced from bath containing additional reagents tend to give a blackening in the test and it may be necessary to wipe off the black material with a spill of paper in order to see the perforation.

6. DETERMINATION OF THICKNESS OF CHROMIUM BY STRIPPING METHOD

6.1 Reagent: Chromium Stripping Solution — Dissolve 20 g of antimony trioxide (Sb_2O_3) in one litre of concentrated hydrochloric acid (*see* **5.3.1.2**).

6.2 Preparation of Surface for Testing — Rub the test piece with a mild abrasive. Degrease it by rubbing with a damp cloth sprinkled over with fine pumice powder, magnesium oxide, or acetone. Dry it in air.

6.3 Method of Testing — Immerse the degreased specimen or the surface to be tested in chromium stripping solution. In case of bulky articles, the test may be localized by using a glass ring about 25 mm in diameter and 25 mm in height clamped in close contact with the test piece and the joint made good by pressing plasticine around the outside lower periphery of the ring.

6.4 To stop action on some parts of an article, the attack may be localized to a selected area by coating the remaining surface with nitrocellulose varnish.

6.5 Record the time, from the appearance of black film over the surface under test to the cessation of gassing, by means of a stop-watch. Note down the temperature of the solution.

6.6 Thickness of deposit is obtained by simple proportion from the time required to dissolve a unit thickness at the temperature of testing (*see* Fig. 8).

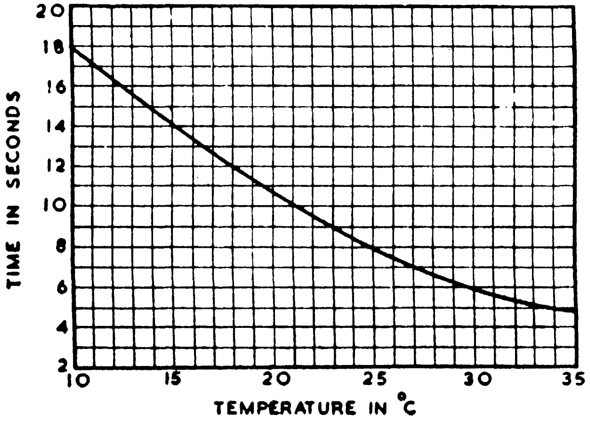


FIG. 8 TIME REQUIRED TO DISSOLVE 0·000 3 mm OF CHROMIUM AT DIFFERENT TEMPERATURE

APPENDIX A

(*Clause* 0.3)

A-1. DETERMINATION OF THICKNESS BY EDDY CURRENT METHOD

A-1.1 The details of the method are given in IS : 6012-1971*.

A-2. DETERMINATION OF THICKNESS BY THERMOELECTRIC METHOD

A-2.1 The instrument utilizes the thermoelectric properties of the junction between the plating and the basis metal. A copper probe terminating in a small hemispherical steep tip and heated to a constant temperature by a small electric winding is applied to plated articles. Since the temperature at the plating basis metal interface is dependent on the thickness of the nickel immediately beneath the heated probe, the thermoelectric potential generated between the hot probe and a cold part of the plated article varies with the coating thickness. This thermoelectric potential, which is less than one millivolt, is amplified electronically and shown on a meter. The instrument as at present available is a robust routine inspection tool for industry to enable rapid, accurate, and non-destructive measurements to be made of the nickel plate on steel, brass and zinc alloy die castings.

A-3. DETERMINATION OF THICKNESS BY COLOMETRIC METHOD

A-3.1 The colometric principle involves anodically stripping the plating from a standard area and measuring the integration of the time and current density. When platings are measured for thickness by this method a small accurately determined area of the surface is attacked by a stripping solution, with or without agitation. At the same time a current is passed through the cell and the plating, and the integrating circuit provides a reading based on the integration of the current density and the time taken to strip the plating.

A-3.2 The operation is very simple, normally occupying only a few minutes and the meter switched itself off when the stripping action is completed. The thickness of the plating thus removed is determined from a dial reading and a multiplying factor. The instrument is mains-operated and is suitable for use in the inspection department by non-technical staff.

---

*Method for measurement of coating thickness by eddy current.

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002
Telephones: 323 0131, 323 3375, 323 9402
Fax : 91 11 3234062, 91 11 3239399, 91 11 3239382

Telegrams : Manaksanstha
(Common to all Offices)

Central Laboratory:	Telephone
Plot No. 20/9, Site IV, Sahibabad Industrial Area, SAHIBABAD 201010	8-77 00 32
Regional Offices:	
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002	323 76 17
*Eastern : 1/14 CIT Scheme VII M, V.I.P. Road, Maniktola, CALCUTTA 700054	337 86 62
Northern : SCO 335-336, Sector 34-A, CHANDIGARH 160022	60 38 43
Southern : C I T. Campus, IV Cross Road, CHENNAI 600113	235 23 15
†Western : Manakalaya, E9 Behind Marol Telephone Exchange, Andheri (East), MUMBAI 400093	832 92 95
Branch Offices:	
'Pushpak', Nurmohamed Shaikh Marg, Khanpur, AHMEDABAD 380001	550 13 48
‡Peenya Industrial Area, 1st Stage, Bangalore - Tumkur Road, BANGALORE 560058	839 49 55
Gangotri Complex, 5th Floor, Bhadbhada Road, T. T. Nagar, BHOPAL 462003	55 40 21
Plot No. 62-63, Unit VI, Ganga Nagar, BHUBANESHWAR 751001	40 36 27
Kalaikathir Buildings, 670 Avinashi Road, COIMBATORE 641037	21 01 41
Plot No 43, Sector 16 A, Mathura Road, FARIDABAD 121001	8-28 88 01
Savitri Complex, 116 G T Road, GHAZIABAD 201001	8-71 19 96
53/5 Ward No 29, R G Barua Road, 5th By-lane, GUWAHATI 781003	54 11 37
5-8-58C, L N Gupta Marg, Nampally Station Road, HYDERABAD 500001	20 10 83
E-52, Chitaranjan Marg, C-Scheme, JAIPUR 302001	37 29 25
117/418 B, Sarvodaya Nagar, KANPUR 208005	21 68 76
Seth Bhawan, 2nd Floor, Behind Leela Cinema, Naval Kishore Road, LUCKNOW 226001	23 89 23
Patliputra Industrial Estate PATNA 800013	26 23 05
T C No 14/1421 University P. O. Palayam, THIRUVANANTHAPURAM 695034	6 21 17
NIT Building, Second Floor, Gokulpat Market, NAGPUR 440010	52 51 71
Institution of Engineers (India) Building, 1332 Shivaji Nagar, PUNE 411005	32 36 35

---

*Sales Office is at 5 Chowringhee Approach, P. O. Princep Street, CALCUTTA 700072	27 10 85
†Sales Office is at Novelty Chambers, Grant Road, MUMBAI 400007	309 65 28
‡Sales Office is at 'F' Block, Unity Building, Narashimaraja Square, BANGALORE 560002	222 39 71

Printed at New India Printing Press, Khurja, India